RESILIENT LENS MOUNTING APPARATUS

FIELD OF THE INVENTION

This invention is directed to a resilient lens mounting apparatus in the form of a canted coil spring for axially and/or radially retaining an optical element in its structural mounting.

BACKGROUND OF THE INVENTION

Prior optical element installation devices have ranged from adhesive bonding of the lens in its barrel or mounting tube to precision machined contoured and threaded retaining rings which engage in the lens mounting barrel and against the lens. Considering the centerline line-of-sight as being the lens axis, there have been various ways of axially securing a lens in a barrel. For example, the lens may engage against a rigid shoulder in the lens barrel and be retained thereagainst by different structures. For example, a snap ring can engage in a groove in the barrel and engage against the lens to hold it against a shoulder. A thin rim may be spun down against the lens to hold it against a shoulder. A male threaded ring may engage a female thread within the barrel and directly bear against the lens to hold it against a shoulder. When resiliency is desired, an elastomeric ring, such as an elastomeric O-ring, made of rubberlike material, can be placed between the lens and its clamp ring.

For radially centering the lens within its support barrel, an elastic material in the form of a ring may provide the necessary support. This elastic material may be molded and placed around the lens or may be injected around the lens after it is in position.

The problem in precision lens mounting is that the lenses or other optical elements have a substantially different thermal coefficient of expansion than the metal or polymer barrel in which they are mounted. When temperature cycling occurs, the lenses and other optical elements may shift and lose their optical alignment. Rigid structures are desirable to achieve and maintain this optical alignment, but the compressive forces generated by such temperature cycling dictate against rigid mounting because brittle optical elements can crack from the stresses resulting from temperature-induced dimensional changes. Shock and vibration tend to displace optical components, so firm mounting is required. Thus, there is need for a lens mounting configuration which maintains axial and radial alignment of the optical elements mounted thereby during vibration and thermal dimensional changes in order to provide a rugged optical system of good precision and long life.

SUMMARY OF THE INVENTION

In order to aid in the understanding of this invention, it can be stated in essentially summary form that it is directed to a resilient lens mounting apparatus wherein a coil spring is employed in a lens mounting structure in order to provide axial and/or radial positioning forces for holding the lens in place. The coiled spring has its loops canted in such a direction as to enhance the resiliency of the spring in the direction in which force is applied.

It is thus a purpose and advantage of this invention to provide a resilient lens mounting apparatus which employs a canted coil spring so as to resiliently urge an optical element into its mounting so that the optical element maintains its optical positional alignment during stressful conditions such as vibration or temperature changes.

It is another purpose and advantage of this invention to provide a resilient lens mounting apparatus which incorporates a canted coil spring as the resilient element so as to provide a more nearly constant force resiliency, as compared to an ordinary coil spring and other resilient mountings.

Yet another purpose and advantage of the present invention is to provide a resilient lens mounting apparatus which does not change or deteriorate with time as compared to synthetic elastomeric structures.

Other purposes and advantages of this invention will become apparent from a study of the following portion of this specification, the claims and the attached drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of the first preferred embodiment of the resilient lens mounting apparatus of this invention, with parts broken away and parts taken on substantially a radial section line for an apparatus which employs axial mounting force between the lens barrel and optical element.

FIG. **2** is a plan view of the resilient canted coil spring employed in the apparatus of FIG. **1**.

FIG. **3** is a side elevational view of the canted coil spring, as seen generally along the line **3—3** of FIG. **2**.

FIG. **4** is a side elevational view of a second preferred embodiment of the resilient lens mounting apparatus of this invention, with parts broken away on a substantially radial plane through the optical axis showing separate canted coil springs to apply axial and radial positioning force on the optical element with respect to the lens barrel.

FIG. **5** is a plan view of the radial positioning canted coil spring of FIG. **4**.

FIG. **6** is a side elevational view of the third preferred embodiment of the resilient lens mounting apparatus of this invention, with parts broken away and parts taken on a radial section through the optical axis, showing a single canted coil spring applying both axial and radial positioning force onto an optical element within a lens barrel.

FIG. **7** is a plan view of the canted coil spring of FIG. **6**.

FIG. **8** is a graph showing spring load versus spring deflection of a canted coil spring.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The resilient lens mounting apparatus indicated at **10** in FIG. **1** is the first preferred embodiment of the apparatus of this invention. Lens barrel **12** is a structure of revolution about the axis **14**. The lens barrel **12** has features thereon which permit the mounting of the lens in a precise location in the optical apparatus, with the axis **14** on the principal line-of-sight of the optical apparatus. The lens barrel **12** has a shoulder **16** therein which is substantially a cone around the axis of revolution. Lock ring **18** is threaded into the lens barrel. It can be removed and tightened therein for the placement and removal of a lens within the lens barrel.

While locking rings are shown as being threaded into the lens barrel, other securing means can be employed for effecting closure. For example, as an alternative to the threaded locking ring, a snap ring can engage in a